

## Design of Uniform Spray Nozzle and Simulation of Carrier Gas Flow Rate Distribution for FTO Thin Film Fabrication Process

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**Abstract :** The FTO thin films were deposited on 15 cm × 15 cm glass substrates by ultrasonic spray pyrolysis, and the influence of process parameters on the film properties was investigated. This paper is the first report on the design of a uniform nozzle and simulating the carrier gas flow characteristics in an ultrasonic spray pyrolysis process. The uniformity of FTO films was evaluated by surface resistivity. The structure, surface morphology and optical properties of FTO films were investigated using scanning electron microscopy, X-ray diffraction, and UV-Vis spectroscopy. The process conditions for film preparation were SnCl<sub>4</sub> concentration of 1.34 mol, NH<sub>4</sub>F concentration of 0.08 mol, temperature of 500 °C, deposition time of 15 min, carrier gas flow rate of 3 m/s, distance between nozzle and substrate of 0.7 cm. The transmittance of the fabricated FTO films was 80%, the surface resistance showed a uniform behavior at 14-15Ω/cm<sup>2</sup> and the X-ray analysis showed a high orientation of SnO<sub>2</sub> crystals in the 200-plane. SEM analysis showed that the crystallite size was constant.

**Keywords :** nozzle design, FTO film, simulation, ultrasonic spray pyrolysis

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